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# THE PREY OF A POPULATION OF *MACHIMUS ATRICAPILLUS* FALLEN (DIPTERA)

### By L. Parmenter, F.R.E.S.

Though Dr. B. M. Hobby (1931, *Trans. ent. Soc. S. Eng.* **6** : 1–42) was able to collect 91 records of *Machimus atricapillus* Fallen with prey, no previous attempt has been made to study a population of the species in one locality. Therefore, when in Cornwall in August, 1941, I found the species to be common in a stretch of about 400 yards of a hedge bordering a wood at Lelant, I collected as many specimens with prey as I could.

The fly was rarely seen except on sunny days. It was found on branches and trunks of trees, telegraph poles and sunny leaves of plants from 1 to 10 feet off the ground. The favourite attitude taken up by the fly was to lie on one side with legs outstretched. Whether this was to enable the sun to shine along the whole length of the body or to keep better watch I could not tell. Sunny patches were preferred for resting and invariably the prey was brought to a sunny spot. The Asilid would alight on a telegraph pole on which were massed a hundred or so *Musca corvina*, 50 *Pollenia rudis* and perhaps three or four of its own species. Though several hours were devoted to the watching of the species I did not once see an attempt to capture a resting fly. All captures were flying insects, sometimes made by means of a " capture dart " but occasionally when just about to alight after a patrol. At these times I imagine the *Machimus* would suddenly catch sight of a fly alighting and drop upon it. Though movement brought death to the victim, speedy and erratic flight brought safety. The commonest insects flying at the time were *Musca corvina*, *Pollenia rudis* and *Eumerus tuberculatus* Rondani. *Eumerus* has a speedy erratic flight as it seeks its host plants. *Musca*, though fast, is steadier in flight, and *Pollenia* is fairly slow. No *Eumerus* was seen to be captured, but *Pollenia* was a frequent victim. Other slow flyers captured included *Syrphus balteatus*, *Melanostoma scalare* and *Beris vallata*. Capture darts and flying attacks were made at pieces of passing, falling leaves and at large wasps, but on close approach the Asilid would not press home its attack.

The specimens are too few to indicate any sexual preference. As to colour of prey, both dull and brightly-hued insects were taken.

The prey appeared to be killed instantly. Several times I had a pill-box over captor and prey almost as they alighted and the Asilid generally dropped as if dead. Though the victim would also slide inert over the floor of the box, the Asilid alone recovered. This feigning of death was not a regular habit although it occurred several times.

I saw no sign of actual or attempted cannibalism, though this is known to occur in several species of Asilidae and other predatory flies. At times a *Machimus* would alight on another's back, but this always proved to be a case of coupling. They would first be head to head but soon one would turn until they sat tail to tail and if disturbed would fly off in this attitude. Pairing lasted several minutes and probably many, as I saw no uncoupling except of a disturbed pair in which coupling had lasted 5 minutes 20 seconds. No form of courtship display was seen.

Table of Prey of 24 ♂, 17 ♀ *Machimus atricapillus* Fallen.

| Captor sex | Diptera | |
|---|---|---|
| | STRATIOMYIDAE | |
| ♂ | *Beris vallata* Forster ♀ | 5 Aug. 1941 |
| ♀ | *Chorisops tibialis* Meigen ♀ | do. |
| | DOLICHOPODIDAE | |
| ♀ | *Xanthochlorus tenellus* Wiedemann ♀ | do. |
| ♂ | *Chrysotus gramineus* Fallen ♀ | 7 Aug. 1941 |
| | EMPIDIDAE | |
| ♀ | Empid sp. ♂ | 2 Aug. 1941 |
| | PIPUNCULIDAE | |
| ♂ | *Pipunculus* sp. ♂ | do. |
| ♂ | *Pipunculus* sp. ♂ | do. |
| | SYRPHIDIDAE | |
| ♀ | *Melanostoma scalare* Fabricius ♂ | 2 Aug. 1941 |
| ♀ | *Melanostoma scalare* Fabricius ♀ | do. |
| ♂ | *Melanostoma scalare* Fabricius ♂ | do. |
| ♀ | *Melanostoma scalare* Fabricius ♂ | 5 Aug. 1941 |
| ♀ | *Melanostoma scalare* Fabricius ♂ | do. |
| ♂ | *Syrphus balteatus* Degeer ♂ | do. |
| ♀ | *Syrphus balteatus* Degeer ♂ | 7 Aug. 1941 |
| ♀ | *Syrphus balteatus* Degeer ♂ | do. |
| Also | *Syrphus balteatus* Degeer seen, not taken | 5 Aug. 1941 |
| | MUSCIDAE | |
| ♂ | *Musca corvina* Fabricius ♂ | 2 Aug. 1941 |
| ♂ | *Musca corvina* Fabricius ♂ | 5 Aug. 1941 |
| ♀ | *Musca corvina* Fabricius ♀ | do. |
| ♂ | Anthomyid sp. ♀ | do. |
| ♀ | Anthomyid sp. ♂ | do. |
| | TACHINIDAE | |
| ♂ | Tachinid sp. ♀ | do. |
| 5 ♂, 3 ♀ | *Pollenia rudis* Fabricius *s.l.* 5 ♂, 3 ♀ | do. |
| 2 ♂ | *Pollenia rudis* Fabricius *s.l.* 2 ♂ | 7 Aug. 1941 |
| Also 2 | *Pollenia rudis* Fabricius *s.l.* seen, not taken | 5 Aug. 1941 |
| | Coleoptera | |
| ♂ | Coleopteron | 2 Aug. 1941 |
| | Hemiptera | |
| ♀ | Hemipteron-froghopper | do. |
| 3 ♂, 1 ♀ | small Hemiptera | 5 Aug. 1941 |
| ♂ | small Hemiptera | 7 Aug. 1941 |
| Also 2 | small Hemiptera seen, not taken | 5 Aug. 1941 |
| | ICHNEUMONIDAE | |
| 1 ♂, 1 ♀ | Ichneumonid sp. | 5 Aug. 1941 |
| ♂ | Ichneumonid sp. | 7 Aug. 1941 |

The material will be preserved in the Hope Department, University Museum, Oxford.

# A NOTE ON THE PREDATORY LARVA OF THE MOSQUITO *CULEX (LUTZIA) TIGRIPES* GRANDPRÉ & CHARMOY (DIPTERA)

By A. J. Haddow, M.B., F.R.E.S.

(*Medical Research Council, Junior Fellow in Tropical Medicine.*)

The observations recorded in this note were made at Kisumu, Nyanza Province, Kenya Colony.

During the early months of 1940 heavy rainfall at Kisumu was accompanied by a very marked increase in the numbers of *Anopheles gambiae* Giles, the principal malaria carrier of the area. At this time many borrow-pits at first swarming with *A. gambiae* larvae were noticed, at a later date, to be inhabited exclusively by larvae of *Culex* (*Lutzia*) *tigripes*. It is known that this larva is predatory on other mosquito larvae but the extent of its usefulness has not been determined. As it appeared almost certain that the borrow-pits had been denuded of their large *A. gambiae* population by the *Lutzia* larvae, a few simple experiments were carried out to find how many larvae could be eaten in a short period.

### Experiment 1.

10 *Lutzia* larvae were isolated in small bowls. To each bowl 10 second-stage *A. gambiae* larvae were added and the bowls were left for 15 hours overnight. Next morning it was found that :—

In 8 bowls all 10 *A. gambiae* larvae had been eaten.
In each of the other 2 bowls, 9 *A. gambiae* larvae had been eaten.

The mean number consumed was thus more than 9.

### Experiment 2.

10 *Lutzia* larvae were isolated as above. To each bowl 10 fourth-stage *A. gambiae* larvae were added. The bowls were left for 15 hours overnight. The results were :—

In 1 bowl 1 *A. gambiae* larva had been eaten.
In 1 bowl 2 *A. gambiae* larvae had been eaten.
In each of 6 bowls 5 *A. gambiae* larvae had been eaten.
In each of 2 bowls 7 *A. gambiae* larvae had been eaten.

The mean number consumed was thus almost 5.

### Experiment 3.

10 *Lutzia* larvae were isolated as above. To each bowl 10 *A. gambiae* pupae were added and the bowls were left for 15 hours overnight. The results were :—

In each of 4 bowls no pupae had been eaten.
In each of 2 bowls 1 *A. gambiae* pupa had been eaten.
In each of 3 bowls 2 *A. gambiae* pupae had been eaten.
In 1 bowl 5 *A. gambiae* pupae had been eaten.

The mean number consumed was thus just over 1. Only the tails were consumed, probably on account of the fairly dense chitinisation of the cephalothorax.

Direct observations were made on the method of feeding. It was found that *L. tigripes* larvae almost always seize large or small Anopheline or Culicine larvae by the tail. In the case of a large larva, the *Lutzia* is dragged about the jar by the galvanically jerking victim. The specialised mouth-brushes, however, appear to penetrate the soft abdominal integument almost immediately and the prey rarely escapes from this firm grip. Effective struggles are of very short duration, seldom lasting more than a minute, though slow movements often continue after feeding has begun, sometimes till almost the entire abdomen has been consumed. The time required for complete consumption of a large larva varies from 15 to 30 minutes. The abdomen is eaten first and disappears very quickly. The head and thorax are consumed more slowly and are often discarded.

In the case of pupae, the small number eaten is not due to unwillingness to accept food of this type, but to the more highly chitinised integument of the pupa and to its very powerful swimming movements, which usually enable it to break loose. Very often this occurs when the *Lutzia* attempts to shift its grip from the tail-paddles, where the pupa is usually seized first, to a spot farther up the abdomen. During 30 minutes observation of a jar, 20 pupae were seized but only 1 was effectively held and eaten. In the other instances the pupa, though sometimes held for almost a minute, finally escaped without apparent injury.

Hopkins (1936) states that *Lutzia* larvae eat one another with reluctance, in the absence of other food. The present observations do not confirm this statement. Larvae placed in a large jar, with abundant *A. gambiae* as food, attacked one another repeatedly but, as in the case of pupal food, the seized larva was rarely damaged as it usually managed to break away in a few seconds with swimming movements of great rapidity and violence. There was no question of the predator relinquishing its prey voluntarily. Large *Lutzia* larvae are able to hold small larvae of their own species and devour them quite indiscriminately in the presence of abundant Anopheline food.

Hopkins (*loc. cit.*) also states that larvae are seized only when they have come into contact with the mouth-brushes of the predator. Certainly this occurs frequently, and the *Lutzia* lies in wait at the surface and does not hunt its prey. More often, however, the food-larva is captured by a very rapid darting movement, rather reminiscent of a snake striking. This occurs whenever a larva comes within striking-distance and the *Lutzia* will even bend its body round to seize a larva approaching from almost directly behind. The judgment is very accurate and though the food-larva may ultimately escape, it is almost always caught and held at first.

At Kisumu the main breeding-place was found to be muddy pools and borrow-pits frequented by *A. gambiae*, though larvae were sometimes taken in reedy pools and swamps, breeding-places of *A. funestus*, *A. coustani* and *A. pharoensis*. Hopkins (*loc. cit.*) mentions that tree-holes are rare breeding-places for this species. It is interesting to record that a large tree-hole, recently searched at Entebbe, yielded several larvae of *L. tigripes*, together with 2 larvae of *Megarhinus brevipalpis* Theobald v. *conradti* Grunberg, and very numerous larvae of *Aëdes* (*Stegomyia*) *apicoargenteus* Theobald, *A.* (*S.*) *africanus* Theobald and *Culex* (*Culiciomyia*) *nebulosus* Theobald.

The eggs are laid in large rafts. During work at Kisumu some small pits were dug during the rains to provide an easily accessible supply of *A. gambiae* larvae. On the day after the pits had been dug, *Lutzia* egg-rafts were present, though no *A. gambiae* eggs were laid till the second day. *A. gambiae* failed to establish itself in these pools, as all the young larvae were eaten by the *Lutzia*, which hatched first.

## REFERENCE.

HOPKINS, G. H. E., 1936, *Mosquitoes of the Ethiopian Region.* I. Larval Bionomics of Mosquitoes and Taxonomy of Culicine Larvae. London (Brit. Mus.).

# NOTES BY E. BURTT, B.SC., F.R.E.S., ON A SPECIES OF *PALOPHUS* (PROBABLY *EPISCOPALIS* KIRBY): A GIANT PHASMID (ORTHOPTERA) FROM TANGANYIKA TERRITORY

By Professor G. D. Hale Carpenter, M.B.E., D.M., F.R.E.S.

Mr. Eric Burtt, entomologist at Tinde Laboratory, near Lohumbo, Tanganyika Territory, wrote to me in July 1941 that he had seen in 1940 a male of this huge insect which measured fifteen and a half inches from the tips of the front legs to the tips of the hind legs: two females were seen, but no measurements sent. In 1941 he met with three females only. One of the first females, enclosed in a cage, deposited upon the gauze numbers of ova which, as Mr. Burtt pointed out, have a curious resemblance in shape to a Lycaenid pupa: they measure about eight mm. long and three across and are dark grey-brown in colour.

I asked Mr. Burtt to send an adult insect which could be identified, and he kindly did so, writing the accompanying notes on 19th January 1942. "The Phasmid eggs, the largest insect eggs I have encountered, are beautifully procryptically coloured, but I do not know any seeds of similar form. I suggest it is probable that they do not represent seeds (as do eggs of other Phasmids) but nodes or warty excrescences on twigs. The female always glues these eggs; she does not drop them about loose at all.

"The specimen I am sending you is rather a magnificent brute, is it not? The procrypsis is marvellous owing to the subdivision of the lower wings into two areas, of which the grey, bark-like anterior portion covers the black posterior portion. The upper wings are greatly reduced to form scale-like objects.

"The gaudy black lower wings are used by the insect to give warning. It rests, of course, with its wings folded and only the grey, bark-like, part showing. When disturbed it swishes its wings open in the position shown in the set specimen: the opening of the wings is accompanied by quite a loud hissing, swishing, noise. The wings are beaten up and down about once per second, say ten or a dozen times, and then held open while the insect moves away. As soon as a calmer atmosphere is restored the wings are shut again; *i.e.* after a few seconds of display."

The specimen, which was exhibited, was kindly examined by Dr. B. P. Uvarov, who identified it as *Palophus episcopalis* Kirby ?, from literature available, the collections not being at present accessible. It shows regeneration of the right front leg, which is considerably shorter and smaller, all parts being reduced. An ovum had been deposited on the left femur from which a larva had hatched. Unfortunately this had been sent pinned and had been so damaged by the process that it could not be properly displayed. The total length of the complete and very fine specimen, which had travelled safely because of very careful packing, is just over fourteen inches.

The combination of extreme procrypsis with a "terrifying" procedure when the insect is disturbed is extremely interesting. It is, of course, well known among Mantidae.

The sudden display of a large, rustling, black area would certainly be as disconcerting to an inexperienced enemy as was the display of the Mantid *Idolum diabolicum* to the young monkey with which I experimented (see 1921, *Trans. ent. Soc. Lond.* **1921** : 52). Dr. Julian Huxley, F.R.S., in his comprehensive study of the biological functions of colour (1938, *Proc. VIII int. ornith. Congr. Oxford* 1934 : 430–455) would classify this behaviour of the Phasmid as "Pseud-antaposematic," *i.e.* bluff and terrifying threat behaviour. There is no reason at all, either *a priori* or *ex experimento*, for supposing the highly procryptic Phasmids to be anything but highly edible. In the case of *Idolum diabolicum* my monkey found on further experience of other specimens that they could be overcome and were very good to eat.

# RESEMBLANCE BETWEEN AN AGARISTID AND A XYLORYCTID (LEP. HETEROCERA)

By Professor G. D. Hale Carpenter.

Captain T. H. E. Jackson, F.R.E.S., of Kitale, Kenya (now serving in the King's African Rifles), recently sent to Oxford some specimens with the note "Herewith a wonderful case of mimicry from Bwamba Valley [the Uganda section of the Semliki valley], August 1941, taken by native collectors at the same place and in the same month, both diurnal. The model is that common blue and white Uganda Agaristid; the mimic, a 'micro.'"

Several specimens of each were received. Dr. Karl Jordan, F.R.S., kindly identified the Agaristid as *Massaga maritona* Butler 1868, described from Sierra Leone, where the white band is slightly narrower than in the Uganda specimens. Mr. H. Stringer at the British Museum (Natural History) kindly identified the presumed mimic as the Tineine Xyloryctid *Cyanocrates grandis* (Druce) 1912, described with an excellent coloured figure in 1912, *Ent. mon. Mag.* **48** : 133, Pl. X, fig. 9 (as *Ommatothelxis*).

The Agaristid has the base of the hind-wings of the same intense blue as the base of the fore-wing, but except for this the simple pattern of white bar crossing deep-blue wings is the same in the two species.

Both have a certain amount of red, shown on the head and thorax of the Agaristid, but on the long femora and tibiae of the hind legs of the Xyloryctid : it would be of the greatest interest to know how this colour is displayed in flight. I have been unable to discover that this likeness has been noticed before, but it may reasonably be claimed as a possible case of mimicry, for the day-flying Agaristidae have many of the characters of relatively distasteful insects. The Xyloryctidae are unusually large for Tineina : one of the two females sent measures 60 millimetres across the two fore-wings, the male is smaller, measuring between 45 and 50 mm. No females of *Massaga* were sent : the males are of about the same size as the *Cyanocrates*.

# ENTOMOLOGICAL GEMS

### By L. G. Hulls, F.R.E.S.

Although the origin of the art of engraving upon hard and precious stones is lost in antiquity, specimens of such work abound in museums and art institutions throughout the world. They are, speaking generally, of interest only to artists, scholars, and members of the fraternity which rejoice in the appellation "expert." It is difficult to believe that these ancient stone engravings can offer anything of interest to the entomologist, and yet, if one searches diligently enough, quite an appreciable amount of entomological matter is revealed. The writer of these notes, prevented by war conditions from indulging in more ordinary forms of entomology, has, during some long hours of night duty, amused himself by searching for such matter amongst the records of ancient engraved gemstones. The search has been confined to books and other material existing in his own house, and, therefore, it is not to be expected that the notes form a comprehensive study.

The ancient engravers used a variety of mineral substances upon which to exercise their art. They were mostly hard stones, and, although some of them could justly be called "precious stones," it is best to consider them all under the heading of "gemstones." There is a considerable number of them, including such substances as Chalcedony, Emerald, Agate, Beryl, Turquoise, Onyx, Lapis lazuli, Cornelian, Rock Crystal, Jasper, and Sardonyx. From time to time, collections of these engraved gemstones have been formed, mostly by private individuals, and many of them have been copied in the various soft glasses known as pastes. These copies, often extremely good likenesses of the originals, have been the source of much chicanery throughout the centuries. Records of many of these engravings have been made in the form of sulphur impressions, usually coloured red. Towards the end of the 18th century, Baron Philip Stosch travelled about Europe in search of engraved stones, and, from these, he made some 2500 sulphur impressions which have come to be known as "Stosch Sulphurs."

The best known and largest collection of paste and sulphur impressions ever made was that of James Tassie, a native of Glasgow. He managed to gain access to nearly all the most celebrated gem cabinets of Europe, as the result of which he produced a vast collection of paste and sulphur impressions. It must not be thought that Tassie was merely an expert in the production of such impressions. He was, in fact, a fine artist, and executed a large number of portraits of contemporary celebrities. He first modelled the sitter's portrait in wax, and, from these wax models, he made impressions in a hard white enamel of his own invention. These Tassie enamels are much sought after by collectors and are of considerable value.

In 1791, eight years before the death of Tassie, one, R. E. Raspe (said to be the author of the travels of Baron Münchhausen), published in two large volumes a descriptive catalogue of the Tassie collection, which, at the time, consisted of nearly 16,000 pieces. It must have been a colossal labour, and could only have been carried out by a person of considerable learning. The text is given in both English and French, and the introduction is a lengthy dissertation on the art of gem engraving. The title-page reads :—

> "A Descriptive Catalogue of a general collection of Ancient and Modern Engraved Gems, Cameos as well as Intaglios, taken from the most

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> celebrated cabinets in Europe; and cast in coloured pastes, white enamel, and sulphur, by James Tassie, modeller. Arranged and described by R. E. Raspe." 1791.

In these volumes, Raspe has arranged the collection in an orderly and systematic manner, commencing with the hieroglyphics of ancient Egypt and ending with comparatively modern engravings of religious subjects, portraits of sovereigns and other celebrities, and so on. A vast field of ancient history and mythology is covered by this description of a collection which, according to Raspe, " Serves for all the purposes of artists, antiquaries, scholars, men of taste, and even philosophers."

The insects mentioned in the catalogue number eight, which is just two fewer than the number referred to in the Bible. It is of interest to compare the two lists.

| *Raspe.* | *The Bible.* |
|---|---|
| | Gnat |
| Bee | Bee |
| Ant | Ant |
| Fly | Fly |
| Grasshopper | Hornet |
| Locust | Locust |
| Beetle | Flea |
| Butterfly | Moth |
| Louse | Louse |
| | Coccus (crimson worm) |

The louse is only mentioned in connection with one engraving, number 13,347. It has the inscription : " A louse, the worthy ornament and remembrances of the Cynicks and Capuchin Friars." There are but two engravings of bees, and Raspe gives no information concerning them. The locust is mentioned in the heading to a group of engravings, but when the items of the group are referred to individually, the insects are all called grasshoppers. This will be referred to later on when the subject of grasshoppers is dealt with.

The insect which can lay claim to the largest influence over these many designs, is, as might be expected, the scarab beetle. Not only do many of the old Egyptian gemstones carry figures of scarabs, but a large number of the engravings are worked on the flat under-surface of stones which have been fashioned in the shape of scarabs. Egypt cannot be held responsible for the large number of mineral scarabs which are in existence, for it would seem that the scarab fashion (or craze) spread to various other countries. The following notes, extracted from " Maspero's Guide to the Cairo Museum " 1906, are of interest in this connection :—

> " . . . The insect of which it is the image is well known. It is the *Ateuchus sacer,* which we so often see near the desert edge, rolling along the ball of dung in which it has deposited its egg, and which, in the cultivated valley, in the evenings, flies to open windows, attracted by the light, and falls heavily into the houses. The Egyptians worshipped it from the most remote antiquity, as they also worshipped other insects, the grasshopper, the cricket, the praying mantis, and the large stag beetles. . . . The scarab readily came to signify all that exists or causes to exist, the organ without which man would not be, namely the heart. . . . So the image of it was multiplied in order to assure to

> living and dead alike a continuance of being, and, like all religious emblems held in general esteem, it was used as an ornament in jewellery. . . . The fashion extended to foreign countries; Phoenicia, Cyprus, Greece, Etruria, Carthage, Sardinia, all made scarabs in imitation of Egypt."

In the Tassie Collection the insect next in order of importance is the butterfly, symbol of Psyche. There is a large number of engravings dealing with the amours of Cupid and this lady, in nearly all of which the latter is represented as a butterfly. It would seem that Cupid had a tremendous keenness for the Rhopalocera, for whether he is playing the lyre, fishing, or practising archery, his attention seems always to wander to the butterfly which is sure to be found near by. There are several engravings of Cupid chasing or dallying with a butterfly, the subject being, of course, that disturbing thing Love. There is a charming engraving of Cupid driving a plough drawn by two butterflies, but, unfortunately, the artist has only provided them with two wings apiece. Butterflies occur in engravings dealing with subjects other than the affairs of Cupid and Psyche. Notable amongst these is one of a Peacock (symbol of Juno) being driven by a butterfly which holds reins attached to the bird's neck. Raspe says of this : "A butterfly holding by the bridle the peacock of Juno, which in one of his feet has a branch of palm, and with the other is perched upon a staff, from which a crown hangs. Is this Reason guiding Ambition and Beauty to make them victorious ? "

Flies are prominent in the set of engravings which deal with Jupiter. Apparently, one of the many surnames given to this god was Muscarius, a word signifying to drive away flies. Jupiter, most powerful of all the ancient gods, is better known to most by reason of his association with thunder. It is somewhat surprising to find him portrayed as an elderly gentleman with a beard composed of two fly wings. In one portrait, the head with its beard of fly wings, is so designed as to approximate the shape of a fly at rest. The description of one engraving is : "Head of Jupiter. In the field two flies." Flies occur under other headings in the catalogue, and are referred to again in the next paragraph, which deals mainly with grasshoppers.

Possibly the most interesting of all the stone engravings depicting insects may be found under the heading "Ceres and Plenty." This group is divided into various parts, one of which deals with the attributes of Ceres. It is here that one finds designs incorporating either grasshoppers, locusts, or both. Raspe groups a number of these under the title "Grasshoppers and Locusts," but in his description of the individual items, the insects are all referred to as grasshoppers. Ceres, being the goddess of corn, Raspe very naturally considered that all designs which included spikes of corn in their make-up must allude to her. All engravings containing ploughs were also put into this group. The question arises as to whether or no Raspe's grasshoppers were really locusts. The main title of "Ceres and Plenty" seems to suggest abundant corn crops, and, on this matter, the locusts had a good deal to say. On the other hand, it may be remembered that the ancient Egyptians worshipped the grasshopper. The point is one of interest, and perhaps some expert orthopterist will decide the issue after examining the sulphur impressions.

In one instance, there is an engraving showing a grasshopper (or locust) driving a plough drawn by two flies, and another picture is of a grasshopper on a vine leaf. I have in my possession a sulphur impression which shows a plough, the driver and team of which appear to be moths. There is no reference to this engraving in the catalogue. Ants appear in this group, and there is one engraving with the title, " A plough with two Ants." There is also one of a car drawn by two ants, one of an ant and a fly, and another of two ants carrying a large grain of barley. One impression, made from an engraved cornelian scarab, has for title, " A Grasshopper upon an ear of corn, with a butterfly upon the wing." In this case the former insect might quite well be meant as a locust, but again, experts must decide.

It is hoped that these brief notes will prove interesting. I have the advantage of possessing not only Raspe's Catalogue, but also many hundreds of the sulphur and paste impressions which once formed part of the famous Tassie Collection.

*Handbook of economic entomology for South India.* By T. V. Ramakrishna AYYAR. pp. xviii + [ii] + 528, illust. (col.). 8vo. Madras (Superintendent, Government Press), 1940. Price Rs. 4. 12. 0.

This book is the successor to *Some South Indian Insects* by T. Bainbrigge Fletcher, published in 1914 and now out of print. It is by the former Government Entomologist of Madras, and some parts of it have already appeared in Indian Government publications.

It is divided in two parts : General Entomology and Economic Entomology, of which the first comprises 85 pages and the second 450 pages.

The first part of the book is introductory and deals with internal anatomy, physiology, reproduction and classification of insects.

The second part deals with the economic rôle of insects, pest control, the insect pests of crops grown in South India, the pests of the household and of stored products, beneficial insects and a series of appendices on insect pests arranged under the orders of insects, classification, study technique, non-insect pests and insectivorous animals and a bibliography of South Indian economic entomology.

# A STUDY OF THE FEEDING OF ADULT STONEFLIES (PLECOPTERA)

By H. B. N. Hynes, Ph.D., A.R.C.S., F.R.E.S.

In a previous paper (Hynes, 1941) it was shown that, contrary to the general belief, the adults of at least some stoneflies, namely those of the sub-order Filipalpia as opposed to those of the Subulipalpia, feed, the food being the lichens and Protococcales which grow on the trunks and branches of trees. Frison (1935) had previously shown that this occurred in U.S.A., and Newcomer (1918) had shown that in California certain species of *Taeniopteryx* caused damage to fruit trees by eating the buds; European workers had, however, maintained that no species of European stoneflies feed as adults (Schoenemund 1924, Kühtreiber 1934, and Mertens 1923), and supported this contention by stating that the mouth-parts of adult stoneflies are reduced. This latter fact is, however, only true of the Setipalpia; in the Filipalpia the mouth-parts are as fully developed as those of the nymphs.

In view of the general contention that adult stoneflies do not feed, the present investigation was undertaken in order to determine whether or no the feeding of the adults was an important part of the life-history, and although the results obtained are in some respects unsatisfactory they do strongly indicate that access to food is necessary for the survival of at least the species *Nemoura variegata* (Olivier), on which experiments were made.

The species *N. variegata* was chosen for investigation because of its abundance, and also because, being a species which breeds in still water, it is possible to rear collected nymphs to maturity without recourse to the use of running water. This species also has a long emergence period (Hynes, 1940), and experiments can thus be conveniently carried on over a period of weeks. Adults were found to feed satisfactorily on the lichen and Protococcales covering old and dead twigs, and to be able to obtain water from pellets of wet cotton wool. Nymphs were obtained from localities in Surrey and Shropshire during the spring and summer of 1941, and were reared to maturity on a diet of dead oak-leaves in shallow pie-dishes. All adults emerged during the hours of daylight, mostly between 7.30 and 12.30 a.m. G.M.T., and were taken within twelve hours of their emergence and confined at room temperature in pairs, either of the same or of opposite sexes, in 3 × 1 in. corked specimen tubes, in each of which was placed a pellet of wet cotton wool. Specimens which were to be fed were also given a piece of twig covered with foodstuff, which was renewed when necessary. Each tube was then examined at least once every day, and dead specimens were removed. In this way the lengths of life, under varying conditions, of 80 specimens were investigated, the results being given in the table on p. 82.

From the table it can be seen that those specimens which were fed lived much longer than those which were not fed, and this difference is shown to be highly significant by the F-test. Statistical analysis by means of the F-test shows also that the figures show no significant difference between the length of life of the two sexes nor between those specimens which were allowed to mate and those which were not. Fed specimens deposited two or three times their volume of faecal pellets during the course of their lives, and were not seen to mate before the seventh day of life, and did not usually do so before the twelfth or thirteenth day. Mating, which lasted about 24 hours, and up to 36 hours with some pairs, occurred up to seven times at intervals of one or two days; none of the unfed specimens was seen to copulate.

Table 1.

| Sex | Food | Mating | Length of life in days | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ♂ | fed | mated | 40 | 31 | 37 | 39 | 21 | 35 | 30 | 36 | 20 | 31 | 32·0 ± 2·19 |
| | | unmated | 29 | 32 | 43 | 36 | 38 | 30 | 36 | 38 | 39 | 43 | 36·4 ± 1·54 |
| | unfed | mated | 3 | 3 | 5 | 3 | 2 | 3 | 7 | 5 | 2 | 4 | 3·7 ± 0·50 |
| | | unmated | 3 | 3 | 4 | 3 | 4 | 4 | 5 | 6 | 4 | 4 | 4·0 ± 0·30 |
| ♀ | fed | mated | 32 | 50 | 41 | 44 | 20 | 37 | 35 | 28 | 40 | 15 | 34·2 ± 3·41 |
| | | unmated | 45 | 46 | 42 | 28 | 32 | 34 | 36 | 33 | 35 | 42 | 37·3 ± 1·92 |
| | unfed | mated | 4 | 6 | 3 | 3 | 3 | 3 | 8 | 3 | 7 | 5 | 4·5 ± 0·60 |
| | | unmated | 5 | 5 | 7 | 4 | 5 | 6 | 3 | 5 | 5 | 7 | 5·2 ± 0·39 |

These observations indicate that specimens of this species which find no food after emergence die before they are able to mate, and certainly before they can produce eggs. Unfortunately none of the fed females extruded eggs under the conditions of the experiments, but all, including those which were not fertilised, became fully gravid after about fifteen or twenty days, and a fertilised female kept under the same conditions, but in a larger container, extruded eggs on her thirtieth day of life. It therefore seems that, at least in this one species, the feeding of the adults is an essential part of the life-history; and the same would appear to apply to the whole of the Filipalpia (comprising in Britain the families Capniidae, Leuctridae, Taeniopterygidae and Nemouridae), which, unlike the Setipalpia (comprising the families Perlodidae and Perlidae), do not feed as adults (Hynes, 1941) and mature their eggs after emergence. Fully matured eggs are to be found in the last nymphal instar of the Setipalpia, but not in the Filipalpia, where they develop after emergence. With regard to mating, the absence of food cannot prevent its occurrence in all species, because males of *Capnia nigra* Pictet will, when less than twelve hours old, mate with newly-emerged females whose wings are not yet fully extended. But even in this species several days of life are necessary in order to allow the eggs to mature, and the adult female probably requires food during this period.

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# THE ORIGIN OF STRIDULATION IN BEETLES

By Gilbert J. Arrow, F.Z.S., F.R.E.S.

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Stridulation, that is the production of squeaking or chirping sounds by friction, it is fairly well known, is very common in beetles; but it is a rather curious fact that in few, if any, of the numerous groups in which the faculty exists does it seem to prevail generally and in many it appears to be confined to a small minority of species. For example, in the Stag-beetles, in which, from their comparatively large size, it should be more easily detected than in most others, only a single species, the Chilean *Chiasognathus granti*, is known to stridulate.

Another conspicuous fact concerning the stridulatory organs of beetles is that, although rather uniform in their essential character, they may occur in almost any part of the body. Wherever two hard surfaces rub against each other in the course of the ordinary movements one is likely to find, in one kind of beetle or another, a special adaptation of the two surfaces resulting in the production of sounds more or less musical in quality. The apparatus usually takes the form of a series of parallel ridges, too fine and close together to be visible to the naked eye, set transversely to the direction of movement, so that they are plucked or scraped by a part of the opposed surface, which may be a sharp ridge or series of ridges, spines or granules. The part of the body upon which the organ is found, while it may be the same in unrelated groups, may be different in different members of the same group. Thus the stridulatory plate or file is situated upon the upper surface of the head and scraped by the front edge of the thorax in members of the unrelated families Endomychidae and Hispidae, while in certain forms belonging to the three very different families Tenebrionidae, Ptinidae and Scolytidae, it is found upon the lower side of the head and operated by the prosternum. In a genus of Carabidae (*Siagona*) and one of Bostrichidae (*Phonapate*) a file upon the fore-leg is rubbed against projections at the side of the prothorax; in a Cicindelid (*Oxychila*), a Lucanid (*Chiasognathus*) and a Tenebrionid (*Cacicus*) the femora of the hind-legs scrape a file upon the outer edges of the elytra; and a file beneath the elytra, rubbed by the abdomen, occurs in particular genera of Carabidae, Pelobiidae, Copridae and Trogidae. One must suppose from this evidence of so many independent origins, combined with so apparently erratic a distribution, that the organs are not of very ancient date nor of any very vital importance. They must, however, be of some real use and benefit and not only to adult insects but to larvae as well, for their existence in a highly developed form in many beetle larvae is perhaps the most remarkable fact concerning them.

What then is the real significance of these organs? In *The Descent of Man* Darwin stated that, from analogy with the crickets, grasshoppers, Cicadas, etc., he expected to find the organs differing in the two sexes, but he was only able to conclude that "in some few Coleoptera stridulation is a sexual character." Amongst about 16 genera known to him to stridulate he found after careful investigation only two in which the organs were not the same in both sexes. Knowledge of the subject has greatly increased since Darwin wrote, the best general account in English being that of C. J. Gahan (1900, *Trans. ent. Soc. Lond.* **1900**: 433), who enumerated very many stridulating genera, belonging to more families than the number of genera known to Darwin. Many others have been discovered since and others undoubtedly remain to be discovered. A good summary has been published by Dudich in 1920–1921, *Ent. Blätt.* **16** : 146; **17** : 136, 145. The existence of the organs in beetle larvae, announced in 1874 by the Danish entomologist Schiødte, was unknown to Darwin and evidently throws an entirely fresh light upon the problem. From the profound character of the modifications by which some of the larval organs have been produced it seems likely that they existed at an earlier period than the corresponding organs of adult beetles. For example, in the family PASSALIDAE the stridulatory plates lie at the bases of the second pair of legs, and the third pair are so entirely altered for operating the instrument that they have lost every trace of their original form and purpose, these larvae having practically become four-legged animals.

Although a few instances unknown to Darwin have been found in which a sexual difference occurs in the stridulating organs, these do not strengthen the case for regarding the faculty as serving for communication between the two sexes. The genera known to him in which male and female differ in this respect are *Heliopathes*, in which the apparatus is confined to the males, and *Oryctes*, in which the vibratory ridges are coarser in the male than in the female. I have myself [1] recorded a few other cases, especially two (*Xenodorus janus* and *Acerus davus*) of which the females are without the apparatus. Other instances were described by Gahan as occurring amongst weevils (*Cryptorrhynchus lapathi*, etc.). It is important to note that in every one of these cases, belonging to very different families of beetles, the organ is found in the same situation, viz. between the terminal part of the abdomen and the elytra. The abdomen of female beetles is apt to become distended with eggs, so that there is no exact correspondence, as in males, between its terminal part and that of the elytra and it is less capable of the rapid movements by which sound is produced. In many cases too, as in *Oryctes* and most of those just mentioned, the terminal segments are differently shaped in male and female in accordance with the different sexual functions and the method of oviposition of the female. In certain weevils described by Gahan the ends of the elytra are in contact with a different segment in male and female respectively, and the differences in the vocal apparatus described were evidently necessitated by this structural difference. The comparative fineness of the stridulatory file in the female of *Oryctes* can be seen also in various related genera but it does not seem to bear the interpretation suggested by Darwin as to the purpose of the resulting sounds. Here also the apparatus is placed at the end of the abdomen and it is almost certain that the movements of the females are less rapid than those of the more energetic males and so require a closer approximation of the vibratory ridges to produce a similar effect. Setting aside these cases of organs at the end of the abdomen, only two isolated cases of sexual difference are known, viz., *Spilispa imperialis*, in which the file is at the top of the head, and *Phonapate*, in which it is upon the fore-leg. In the former it is present only in the male and in the latter only in the female. These two remarkable exceptions are at present quite inexplicable.

It is evident that there is a great difference in this respect between beetles and such insects as the Cicadas and crickets whose vocal organs are chiefly associated with the male sex, as there is also in the volume of sound produced. Beetle voices are so feeble in comparison that only a very small fraction of the organs now known to exist can ever have been heard by human ears and it is likely that many are quite inaudible to man. Probably very few could be heard at a distance of more than a yard or so. In consequence scarcely anything is yet known as to the purpose served by them. They appear to be used at times of excitement and Mr. Hugh Main believes he has heard the female

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[1] 1904, *Trans. ent. Soc. Lond.* **1904** : 719.

*Geotrupes* calling to the male when engaged together in provisioning their nest; but the evidence of this can hardly be considered sufficient for forming a definite conclusion. The loudest beetle voices seem to be those of the semi-social PASSALIDAE, already mentioned, which have the most highly developed of all larval stridulating organs. Ohaus has recorded in 1900, *Stettin. ent. Ztg* **61** : 164 that one of these beetles in Brazil, when confined in a vessel in his room, chirped so loudly at night that he was obliged to remove it from the room. He relates also that in breaking up a log he found and threw aside a family of these beetles consisting of larvae and adults. During his further operations he heard continual chirping proceeding from these and before leaving the spot he turned over a piece of wood lying on the ground and found beneath it the two parents and four larvae, while two other larvae were making their way to the same shelter as fast as intervening obstacles allowed, guided, as he believed, by the voices of their parents. The incident happened more than 40 years ago and no confirmation of it has yet been obtained. Other investigators who have studied the habits of the PASSALIDAE have regarded his statement as owing something to his imagination but the experiment of repeating the circumstances does not appear to have been tried. Should the fact of such inter-communication amongst the PASSALIDAE be confirmed, however, it would not throw much light upon the possession of vocal organs by other larvae. Those of *Geotrupes*, for example, lead completely solitary lives throughout the period of immaturity, each inhabiting a separate underground chamber, so that no inter-communication is possible.

Darwin recorded in *The Descent of Man* (Chapter X) that the grotesque Stag-beetle, *Chiasognathus*, in Chile, when molested assumed a threatening attitude and at the same time stridulated loudly. It is possible that loud sounds may have an intimidating effect upon enemies, but this will not explain the very feeble voices of the great majority of stridulating beetles. It seems possible, however, that the vibrations by which the sound is produced, when communicated through the exterior of a hard-shelled insect, may cause an unpleasant sensation in the mouth of the creature seizing it and the sound may serve as a warning against repetition of the attack.

Although some of these organs are very highly developed, different species show them in many stages of development, some having a comparatively coarse structure which, instead of a high-pitched note, must produce only a grating or rustling sound. The closely packed ridges towards the end of the abdomen in Dynastid beetles, which are scraped by the ends of the wing-covers, show many degrees of fineness. These no doubt represent stages in the process by which the perfected instrument has been gradually evolved, unmusical grating sounds having first resulted in all cases. Darwin considered that the slight rustling sound produced by the rubbing of the undifferentiated surfaces originally served to attract the attention of the other sex and that from its use in that way improvement gradually resulted by the operation of sexual selection. It is known, however, that the olfactory sense of insects is capable of bringing them together, sometimes from considerable distances, and to suppose that these slight rustling sounds could lead to recognition at a distance in a world full of sound is to assume the possession of an auditory sense as well developed as the olfactory sense. Of this there is little evidence. Nothing has been found in beetles resembling the supposed auditory organs of other vocal insects nor is there any reason to believe that it is the habit of female beetles of any kind either to gather at the summons of the male or to issue a summons themselves. The supposition that beetles are able to hear rests upon rather slender evidence.

A Death-watch beetle will respond to the tapping of another individual of its species but does not distinguish it from similar taps produced by man with a variety of instruments. It is likely therefore that the stimulation to which it responds is the vibration of the surface with which its feet are in contact.

It seems to me probable that many insects perform movements of different kinds for their own enjoyment, such as the cricket which chirps for hours together or the flies that hover or dance in the air, the satisfaction being found, not in the sounds that may result from the movements, but in the exercise of the muscles, as the lark or the nightingale probably finds enjoyment more in the exercise of its throat-muscles than in the music so produced, whether or not this has acquired a value of its own.

In certain beetles two stridulating-organs have been found in different parts of the body of the same insect. This is the case, according to Gahan, in the Longicorns of the genus *Plagithmysus*, and I have recorded the same thing in EROTYLIDAE and ENDOMYCHIDAE (1924, *Trans. ent. Soc. Lond.* **1924** : 134). It has also been found in Water-bugs of the genus *Corixa* that two sets of organs producing quite different sounds exist together. If the object of the organs were to produce a distinctive call-note the emission of two different sounds, whether at the same or different times, would tend to defeat it by contributing to the general confusion; but, if the sound was originally incidental only and the friction giving rise to it had a value of its own, this objection disappears. If, as it seems reasonable to suppose, satisfaction is derived from the exercise, the sense of well-being probably reflects an actual physical benefit obtained from it. Natural selection would bring about improvement of the parts concerned in a beneficial operation. The change from a comparatively irregular to an extremely regular structure of the vibratory parts may be concerned with the wider distribution of the vibrations through the chitinous shell of the insect, which may have, as I have suggested, a protective value against predacious enemies. In the case of larvae, whether solitary or not, such vibrations may conceivably serve to baulk parasites attempting to lay eggs upon them.

The sounds resulting from the movements may, although originally without significance, have eventually acquired uses differing in different cases; and, if the origin I have suggested for the organs of beetles is correct, it will also serve to explain the early stages of organs so much more vocally effective as those of crickets, grasshoppers and other insects.

# STUDIES ON THE CHEMISTRY OF PIGMENTS IN THE LEPIDOPTERA, WITH REFERENCE TO THEIR BEARING ON SYSTEMATICS.

## 2. RED PIGMENTS IN THE GENUS *DELIAS* HÜBNER

By E. B. Ford, M.A., B.Sc., F.R.E.S.

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*Delias* is the largest genus of the Pieridae, comprising 159 known species. Its systematics have been studied in exceptional detail, for the results embodied in *Lepidopterorum Catalogus* (Talbot, 1932–35) are greatly amplified in Talbot's monograph (1928–37). The species are almost entirely Indo-Australian in distribution, though a few enter the south-eastern part of the Palaearctic Region. Their white and yellow pigments contain no anthoxanthin (Ford, 1941), but two types of red pigment are distributed among them. This is a rare colour in the Pieridae, being found only in a few other genera, notably *Pereute* and *Archonias*.

No difference between the two red pigments of *Delias* can be detected by the eye. However, they are easily distinguished by other means. One (" pigment D ") is converted to a bright yellow shade by strong mineral acids (*e.g.* hydrochloric acid) and reconverted to red by alkalis (*e.g.* ammonia). The other (" pigment E ") is almost unaffected by acid. Most of the species that are marked with red possess one or the other of these substances alone, type D being much the commoner. In two of them, however, both types seem to be present together, so that their red areas turn orange on exposure to acid owing, apparently, to the mixture of the yellow so obtained with unaltered red.

Hopkins (1895) described the solubilities and other reactions of three types of red pigment in the Lepidoptera. One of them is that found, for example, in the Vanessidi. It may for convenience be called " pigment C." Acids cause it to assume a duller tone, and the colour is not entirely restored by subsequent treatment with an alkali. It is rapidly soluble in hot water or in an aqueous solution of ammonia, and it does not react to the murexide test for uric acid.

The second of these pigments (" pigment A ") was originally described by Perry-Coste (1890–91). It is changed to bright yellow by hydrochloric acid and reconverted to red again by an alkali, both reactions taking place with great rapidity. Hopkins showed that it is soluble only to a very slight degree in hot water or dilute alkalis, and that it does not give the murexide reaction. This pigment is widespread in the Lepidoptera, and its occurrence and genetics have been discussed by Ford (1937). It is responsible for the red colours of many groups: in particular, the Arctiidae, the Zygaenidae and, in the Papilionidae, for those of *Polydorus* (except the Polydamas Group) and of *Graphium*; but not of *Papilio*, save in two exceptional instances out of fifty-two species tested (Ford, 1940).[1]

The third red pigment examined by Hopkins is that occurring in the majority of the genus *Delias* (" pigment D "); he made a special study of it in *D. eucharis* Drury. It is rapidly soluble in hot water and dilute alkalis, and gives the murexide reaction. However, Hopkins did not mention that it reacts with acids and alkalis in the same way as that last described (pigment A), which he had studied in *Polydorus aristolochiae* F. For, when the wings of any *Delias* species possessing pigment D are fumed with hydrochloric acid, the red areas are converted to bright yellow, while they can be reconverted to red by an alkali. There is in fact nothing to distinguish between pigments A and D when subjected to this test, though their other reactions demonstrate that they are widely different.

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[1] My subsequent work has reduced the proportion of exceptions in *Papilio* to 2 out of 107 species.

As already mentioned, I now find that a red pigment which does not react in this way also occurs in *Delias*, but much more rarely. This may be called "pigment E." It indeed becomes very slightly paler on exposure to hydrochloric acid, but it cannot be changed from bright red by this means. This is still true after an exposure of 14 hours, when the insect is becoming limp: similar treatment would convert the other pigment of *Delias* (pigment D) to a yellow shade in five minutes. In other respects, however, the two types have much in common, for pigment E, which remains red on exposure to acid, is none the less rapidly soluble in hot water and dilute alkalis, and gives a positive murexide reaction. This is in accord with the view of Hopkins that the pigments of the PIERIDAE (except the black) are all uric acid derivatives. The species which I used for the solubility tests and the murexide reaction was *D. acalis* Godart (= *thysbe* Cramer).

I am much indebted to Mr. J. R. P. O'Brien for his kindness in working out the following technique to make the murexide test suitable for the present investigations. The red areas of the wings are cut into small pieces and soaked in concentrated nitric acid (sp. gr., 1·18) for half an hour. The liquid is then removed to a small porcelain dish by means of a teat-pipette, and evaporated to dryness on a water-bath. A reddish residue is left if the reaction is likely to be positive. After cooling, strong ammonia solution is added gradually by means of capillary tubing, when an ordinary murexide reaction is obtained if the pigment contains uric acid compounds. That is to say, a reddish-violet colour is produced. If the amount of pigment is small, this may be extremely transient, and a careful watch for it must be kept as the ammonia is added.

A difficulty arises when red scales are present on one side of the wing only, and white on the other. Since the white pigment of the PIERIDAE gives a positive murexide reaction (Hopkins, 1895), it must not be allowed to contaminate the material to be tested. In these circumstances, it is necessary to remove the scales from one surface of the wings. I am much obliged to Mr. E. Taylor for bringing to my notice a technique admirably suited to this purpose. It is due to Landois (1866). Celloidin is dissolved in equal parts of absolute alcohol and ether, to give a solution of the consistency of a thin syrup. Several drops are poured on to a sheet of paper and spread evenly over an area of the required size. The wing, which has previously been cut from the body, is then quickly laid upon the liquid celloidin and pressed gently into it. The surface to be preserved must of course be placed upwards. The solution is allowed to dry thoroughly, for at least an hour, when the wing-membrane can be pealed off intact. It will then be found that the scales have adhered to the celloidin, leaving the wing completely diaphanous on one side. The red areas can now be cut out. In a number of species, however, black scales are interspersed with the red. No error is introduced here, since Hopkins found that the black pigment of the PIERIDAE does not give a murexide reaction, a fact which I have myself confirmed.

It is of course not possible to examine the solubility of the pigments or to apply the murexide test widely, since these procedures destroy the specimen, and many of the species are rarities which must not be damaged. However, in addition to *Delias acalis* and *D. eucharis* Drury already mentioned, I have demonstrated the solubility of the red pigments, and obtained a positive murexide reaction from them, in *D. nigrina* F., *D. harpalyce* Donovan, and *D. mysis* F. This sample is widely scattered through the genus, so that there is no reason to doubt that the red pigments of *Delias* are uniform in their degree of solubility and response to the murexide test.

Pigments A and D are converted to bright yellow by nitric acid, as they are with hydrochloric acid, and restored to red by ammonia. However, when kept somewhat longer in nitric acid the scales become colourless, and this effect cannot be reversed by an alkali. Partial restoration only takes place if the decolorisation has started. Pigment E is as easily decolorised by nitric acid as are A and D but it remains red throughout the process, for the red scales gradually lose their colour without passing through a yellow stage. The contrast between the two types of red pigment in *Delias* is very striking when subjected to this treatment.

I may add for completeness in comparison that the red pigment occurring in *Papilio*, and in the Polydamas Section of *Polydorus*, is distinct from any of these. This may be called "pigment B." It resembles that of the Vanessidi (pigment C) to the extent that it does not give the murexide reaction and is not converted to bright yellow by an acid, but it differs in being insoluble in hot water and dilute alkalis. Probably therefore it is a melanin. I have studied its reactions with acids and alkalis in a large number of species (Ford, 1940), and have examined its solubility and applied the murexide test in *Papilio anchisiades* Esper, *P. torquatus* Cramer, *P. polytes* L. (female form *romulus* Cramer), *P. aegeus* Donovan, and *Polydorus polydamas* L.

The distributions and reactions of these red pigments are given in Table 1. I have arbitrarily assigned distinguishing letters to them for convenience; Types A and B have already been so called in a previous work (Ford, 1940). None of these pigments can be dissolved in a fat-solvent (*e.g.*, carbon bisulphide), so that they do not appear to include any of the carotin group.

TABLE 1.

The occurrence and reactions of some red pigments in the Lepidoptera.

| | Occurrence | Changed to yellow by HCl, restored by $NH_3$ | Solubility in hot water and dilute alkalis | Murexide test |
|---|---|---|---|---|
| A | *Graphium*<br>*Polydorus* (except Polydamas Group)<br>ARCTIIDAE<br>ZYGAENIDAE | yes | very slight | negative |
| B | *Papilio*<br>*Polydorus* (Polydamas Group only) | no | insoluble | negative |
| C | Vanessidi | no | great | negative |
| D | *Delias* (except Pasithoe Group) | yes | great | positive |
| E | *Delias* (Pasithoe Group) | no | great | positive |

Seventy-four of the known species of *Delias* possess pigments which are distinctly red. I have been able to examine seventy-one of these. The remaining three (*lemoulti* Talbot, *ellipsis* Joannis, and *mayerhoferi* O. Bang-Haas) are not accessible owing to war conditions. Fortunately the test required to distinguish between the two pigments of *Delias* does not damage the specimens. Indeed some of those studied are species of great rarity, including even unique types (*wollastoni* Rothschild, *klossi* Rothschild, *eileenae* Joicey & Talbot).

The results of this investigation are given in Table 2, in which the species are arranged according to Talbot (1928–37). It will be observed that all the *Delias* examined possess pigment D except the Pasithoe Group, in which none does so.

TABLE 2.

The distribution of two types of red pigment, D and E, in the genus *Delias*.

| | Species | Group |
|---|---|---|
| D | *lecerfi* Joicey & Talbot | Stresemanni |
| D & E | *sagessa* Fruhstorfer | Geraldina |
| D | *microsticha* Rothschild | ,, |
| D | *hypomelas rubrostriata* Joicey & Talbot | ,, |
| D | *thompsoni* Joicey & Talbot | ,, |
| D | *castaneus* Kenrick | Bornemanni |
| D | *caroli* Kenrick | ,, |
| D | *bornemanni* Ribbe | ,, |
| D | *nais* Jordan | ,, |
| D | *iltis* Ribbe | Iltis |
| D | *mesoblema* Jordan | ,, |
| D | *bakeri* Kenrick | ,, |
| D | *callista* Jordan | ,, |
| D | *hapalina* Jordan | Weiskei |
| D | *campbelli* Joicey & Talbot | ,, |
| D | *phippsi* Joicey & Talbot | ,, |
| D | *weiskei* Ribbe | ,, |
| D | *callima* Rothschild & Jordan | ,, |
| D | *marguerita* Joicey & Talbot | ,, |
| D | *kummeri* Ribbe | Kummeri |
| D | *ligata* Rothschild & Jordan | ,, |
| D | *isocharis* Rothschild & Jordan | ,, |
| D | *alepa* Jordan | ,, |
| D | *dixeyi* Kenrick | ,, |
| D | *bothwelli* Kenrick | ,, |
| D | *joiceyi* Talbot | Nigrina |
| D | *oryntion* Godman & Salvin | ,, |
| D | *dohertyi* Oberthur | ,, |
| D | *prouti* Joicey & Talbot | ,, |
| D | *eximia* Rothschild | ,, |
| D | *duris* Hewitson | ,, |
| D | *funerea* Rothschild | ,, |
| D | *nigrina* F. | Nigrina |
| D | *wollastoni* Rothschild | ,, |
| E | *henningia* Eschscholtz | Pasithoe [1] |
| E | *woodi* Talbot | ,, |
| E | *crithoe* Boisduval | ,, |
| E | *pasithoe* L. | ,, |
| E | *acalis* Godart | ,, |
| E | *ninus* Wallengren | ,, |
| D | *klossi* Rothschild | Clathrata |
| D | *descombesi* Boisduval | Belisama |
| D | *splendida* Rothschild | ,, |
| D | *belisama* Cramer | ,, |
| D | *levicki* Rothschild | ,, |
| D | *zebuda* Hewitson | ,, |
| D | *eumolpe* Smith | ,, |
| D | *madetes* Godman & Salvin | ,, |
| D | *aruna* Boisduval | ,, |
| D | *diaphana* Semper | ,, |
| D & E | *aganippe* Donovan | ,, |
| D | *harpalyce* Donovan | ,, |
| D | *eileenae* Joicey & Talbot | Dorimene |
| D | *sacha* Smith | Isse |
| D | *candida* Vollenhoven | ,, |
| D | *eucharis* Drury | Hyparete |
| D | *hyparete* L. | ,, |
| D | *rosenbergi* Vollenhoven | ,, |
| D | *mitisi* Staudinger | ,, |
| D | *periboea* Godart | ,, |
| D | *fasciata* Rothschild | ,, |
| D | *sambawana* Rothschild | ,, |
| D | *poecilea* Vollenhoven | ,, |
| D | *ceneus* L. | ,, |
| D | *timorensis* Boisduval | ,, |
| D | *mysis* F. | ,, |
| D | *euphemia* Smith | ,, |
| D | *salvini* Butler | ,, |
| D | *bagoe* Boisduval | ,, |
| D | *schoenbergi* Rothschild | ,, |
| D | *argenthona* F. | ,, |

[1] The Pasithoe Group was called the "Aglaia Group" by Talbot, for the species from which it is named (*D. pasithoe* L.) was known until recently as *D. aglaia* L. In addition, the prior name *acalis* Godart has now been substituted for *thysbe* Cramer.

The red colours of *Delias* are usually of a bright clear shade, but in some the markings on the underside are of a rich maroon, as in *bornemanni* Ribbe, *nais* Jordan, *callima* Rothschild & Jordan, and others. On exposure to acid this becomes converted to a yellowish-grey, the original tint being restored by ammonia. Examination with a lens shows that this colour is produced by a mixture of red and black (or grey) scales, and that the former become yellow after treatment. Moreover, the red pigment can be extracted from the wings by means of a dilute alkali, giving a reddish-tinted solution similar to that obtained from the bright red spots of other species. This has been demonstrated in each of the three species named. It is clear therefore that the maroon-coloured forms may be treated as red-marked species, and that their red pigment is of type D.

Two species, however, are peculiar in that they seem to possess both kinds of red pigment (D and E). These are *sagessa* Fruhstorfer and *aganippe* Donovan. Their red markings are therefore converted only to an orange shade by hydrochloric acid. Mr. G. Talbot informs me that he had come to the conclusion, upon structural grounds, that these are both rather exceptional: so much so that he had placed them in their respective groups somewhat tentatively. Thus the evidence derived from a study of their pigmentation is in accord with the view, based on other considerations, that these are isolated species.

Mr. Talbot tells me that having regard to the additional information presented here, he would now separate *aganippe* Donovan from the Belisama Group and place it in a group by itself (forming a new "Aganippe Group") between the Belladonna and the Pasithoe Groups. The Belladonna Group comprises yellow-marked species none of which possesses red pigments, consequently it is not included in the present analysis. It occupies a position between the Nigrina and the Pasithoe Groups. On the other hand, *sagessa* Fruhstorfer is better retained in the Geraldina Group, for this contains some very distinct forms. Though an isolated species, it is on structural grounds more closely allied to the others of its group than is *aganippe* Donovan.

During the course of this work, two suggestions have been made to me which, though reasonable, are incorrect. They must briefly be mentioned lest they should be raised again.

First, it chances that throughout the Pasithoe Group, in which pigment E occurs alone, the red areas occupy the base of the hind-wings only; while among the other Groups, in which pigment D is present, red sub-marginal spots and red bands crossing the disc of the hind-wings are frequent on the underside. The view was expressed that red spots occupying distinct regions of the wing might have different chemical constitutions. A survey of the genus makes such a concept untenable. Red marks are found at the base of the hind-wings on the underside in many species outside the Pasithoe Group, such as *castaneus* Kenrick, *nigrina* F., *descombesi* Boisduval and numerous others, yet here they are due to pigment D; while, as already mentioned, pigment E is present (in addition to D) in the red sub-marginal spots of *D. sagessa*. The distribution of the two types of red pigment in *Delias* is not related to their position on the wing.

Secondly, it was suggested that the failure of the red markings of the Pasithoe species to turn yellow on exposure to acid might be due to a difference not in their red pigment but in their scales, which may be impermeable. This is not correct, and for several reasons. Pigment D is changed from red to yellow by exposure for a few minutes to a concentrated atmosphere of hydrochloric acid. In the Pasithoe Group the pigment remains red after a similar exposure lasting for fourteen hours. It cannot be supposed that the degree of chitinisation of the scales could make so great a difference to the passage of the gas, especially as the red pigment in the Pasithoe Group is as easily soluble both in hot water and dilute alkalis as it is in the other species of the genus. However, the behaviour of these pigments when exposed to nitric acid appears to be decisive. As already mentioned (p. 9), both are decolorised by this means, pigment D passing through a yellow stage during the process, while E does not. It is clear therefore, on the one hand, that the acid reaches pigment E, and on the other that it does not turn it yellow. Thus it must be in the constitution of their red pigments, not in the degree of permeability of their scales, that the Pasithoe Group differs from the majority of the *Delias* species.

The present classification of *Delias* is largely due to the work of Talbot, and the distribution of the two types of red pigment occurring in that genus proves to be strictly related to it. Chemical considerations therefore support this classification on grounds wholly distinct from those upon which it had been constructed.

During the course of this work I have received valuable help, which I gratefully acknowledge, from Prof. G. D. Hale Carpenter, Mr. N. D. Riley, Prof. R. A. Fisher, Mr. G. Talbot, Mr. J. R. P. O'Brien, Prof. E. S. Goodrich, and Mr. A. G. Gabriel.

## SUMMARY.

1. Five types of red pigments have now been distinguished in the Lepidoptera. Their distributions and reactions are given in Table 1.

2. Two of these red pigments (called, for convenience, D and E) occur within the genus *Delias*. These are both soluble in hot water and dilute alkalis, and give a positive murexide reaction. No difference between them can be detected by the eye, but they can be distinguished by treatment with acids. One (pigment D) is converted to a yellow shade by hydrochloric acid, and is then reconvertible to red by ammonia. The other (pigment E) does not become yellow on acidification.

3. Pigment D is present in all red-marked species of *Delias*, except those of the Pasithoe Group, from which it is without exception absent (Table 2).

4. Two species (*sagessa* Fruhstorfer and *aganippe* Donovan) appear to possess both types of red pigment (D and E), so that their red markings become orange on acidification. In this respect they are distinct from the others of their respective Groups. Also Mr. G. Talbot informs me that he had found on structural grounds that these two species are somewhat isolated.

5. *aganippe* Donovan should now be placed in a new group by itself (the Aganippe Group) between the Belladonna and the Pasithoe Groups. *sagessa* Fruhstorfer can be retained in the Geraldina Group, as this already contains some very distinct forms.

6. The two types of red pigment (D and E) found in *Delias* are not distributed at random according to the present arrangement of the species, but their occurrence is strictly related to it. Chemical considerations therefore support the classification of this genus on grounds wholly distinct from those upon which it had been constructed.

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# ACTIVITY OF *GLOSSINA PALLIDIPES* AT NIGHT (DIPTERA)[1]

By T. W. Chorley, F.R.E.S., and G. H. E. Hopkins, M.A., F.R.E.S.

Vanderplank has shown that very much larger numbers of *G. pallidipes* may be captured on days following dark nights than on those following moonlight nights. He has drawn from this fact the reasonable inference that "*G. pallidipes* feeds on moonlight nights and does not feed so freely, if at all, on dark nights." He reports two direct observations which show that *G. pallidipes* is active at night.

The observations now recorded are very incomplete but seem worth publishing because they provide a certain amount of direct confirmation of Vanderplank's inference, and because of the dearth of published observations on this very important point in the biology of *G. pallidipes*. Owing to pressure of other work, and the fact that the main object of the observations has been attained, an opportunity to carry the observations farther is not likely to arise.

The work was carried out at Wokola, in Buruli county, 88 miles due north of Kampala. This portion of Buruli has recently become heavily infested with *pallidipes*, and an important route of the cattle-trade has thereby become unusable. The statements, to be found in most old books about Africa, to the effect that cattle can safely be taken through belts of *G. morsitans* if the journey is carried out at night, suggested the necessity of testing whether the same might be true of *G. pallidipes*, though the known partly-crepuscular habits of the latter species gave small grounds for expecting a favourable result.

The "fly-round" for the observations was a 2½-mile strip of the road leading northwards from Wokola. This strip runs through samples of all the main vegetational types found in northern Buruli, including dense thicket, savannah and almost treeless wet-weather swamps ("vleis").

The experiments were carried out with an ox as bait, to which a "kongoni-screen" was added after the first night. The screen is a dry skin of a kongoni or hartebeest (*Alcelaphus jacksoni*), folded over a pole and carried by two porters in such a way that the sides of the skin hang about six inches above the ground. The use of the screen was partly to increase the size of the bait and partly to test the attractiveness of the screen against that of an ox so that the screen might be substituted for an ox in future work if it were found to be sufficiently attractive. The same ox and the same trained staff were used for all the observations.

The times given in these notes are East African Standard Time and the watch was checked daily by the B.B.C. time-signal; the 24-hour notation is employed.

## Observations on Moonlight Nights.

These observations were carried out on the nights of the 8th–9th July and 9th–10th July 1941. On the first night work began at 19.25, about three-quarters of an hour after sunset and as the moon was rising, and went on until midnight; on the second night work began at midnight and went on until 6.15.

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[1] Published by permission of the Director of Medical Services, Uganda.

On both occasions there was a very bright full moon and a cloudless sky. There was no wind on either occasion.

The method employed was as follows :—Two untrained porters went about eight yards ahead, beating the bushes on each side of the road in order to disturb resting tsetse by imitating the way in which a moving herd of cattle would brush against the bushes. The ox followed, flanked by an African Entomological Observer on one side and T. W. C. on the other, and followed by the herdsman. Then came two more porters, followed by an African Tsetse-Surveyor; after the first night these latter porters carried the kongoni-screen. All three trained members of the party were armed with tsetse-nets and electric torches, and the torches were flashed on for a few seconds at intervals of two or three minutes to enable a search for tsetse to be made; on these occasions the ox was sometimes halted and sometimes not. Tsetse could easily be seen, either on the screen or on the ox, by the aid of the torch. No tsetse other than *G. pallidipes* were encountered, nor is any other species known to occur in the area, which has been rather thoroughly examined.

On the return journey on the first night a lighted hurricane-lamp was carried a few yards in front of the ox, since Africans driving cattle along a road at night would normally use a lamp of this kind, and it was thought possible that tsetse might be attracted by the light. The presence of the lamp made no appreciable difference in the numbers of tsetse observed and at no time were they seen flying round it.

The very long time (more than four hours) occupied on the first night by the double journey of five miles resulted from the frequent halts to collect tsetse, the exasperatingly obstinate dislike of a single ox to being driven along a road at night, and the strenuous objection of the ox in question to permitting tsetse to be caught on its person. The use of the screen improved matters considerably, because it gave no trouble in the two latter respects and a large proportion of the tsetse disturbed from the ox promptly settled on the screen. Tsetse which settled on the ox were recorded, allowed to feed to make them more amenable to being caught, and were then caught if possible.

The results of the two rounds carried out on moonlight nights are shown in Table 1, and those of a round made in daylight, on the evening of the 10th July, in Table 2. The latter round was carried out as a control and was begun at 16.30, thus covering the time of maximum daylight activity of *G. pallidipes*; both ox and screen were used and the route was the same as at night. There was a little wind at first.

It will be noted from these tables that activity went on throughout the night and that both sexes were concerned. The number caught or seen on the moonlight rounds (62) is little smaller than the 76 observed on the daylight traverse, and the difference is possibly accounted for by the greater difficulty of seeing tsetse at night; for the same reason the " swarm " must be ignored as it would certainly not have been seen at night. It seems unlikely that the capture of 42 specimens prior to the daylight round would have had an appreciable effect on the size of the tsetse-population in the area. A further point of some interest is the marked increase of activity shown in Table 2 as dusk set in. This illustrates clearly the more or less crepuscular habits of the species.

## OBSERVATIONS ON A DARK NIGHT.

The observations on activity of *G. pallidipes* on a dark night were made, on the same route at Wokola and under exactly the same conditions, on the moonless night of the 23rd–24th July 1941. Unfortunately they do not permit of exact comparison with the earlier observations because there were obviously far fewer tsetse on the round on this occasion, a daylight search with the ox and screen from 16.30 to 18.45 on the afternoon of the 23rd only resulting in seven *pallidipes* (which were purposely not caught) being seen. The cause of this reduction is not known, but two possible contributory factors were noted : a gang of labourers had been working on the road for several days previously and the tsetse had fed freely on them and were presumably not hungry, and the herd of buffalo observed on the earlier occasion had apparently moved away ; it is known that buffalo are a very favourite food of *pallidipes* and that the fly sometimes move out of an area with a herd of buffalo. The night of the observations was dark but with a clear starry sky until about 2.30, when it clouded over and became pitch-dark.

The results of the search were so meagre that a table is unnecessary. Work started at 19.30 and continued, with rests from 22.30 to 23.30, 2.30 to 3.30 and 5.30 to 6.00, until 6.30 (half an hour after dawn). A female *pallidipes* was seen on the ox at 19.40 and caught on man at 20.20, a male was caught on man at 3.55, when it was extremely dark, and two were seen at 6.10, of which one fed full on the ox. The figures are too small to show more than that there is a certain amount of activity by *pallidipes* even on a very dark night.

## GENERAL POINTS.

The favourite site of attack by a given species of tsetse has an important bearing on methods of catching the species concerned. It was noted that the great majority of the *pallidipes* seen during these observations settled low down, whether on screen, ox or man, but actual figures are available only in the case of man. On the two moonlight nights 21 specimens were observed on man, of which 17 were on the legs, 2 higher up, and in 2 cases the site was not recorded.

A further important point is whether the tsetse were actually feeding at night. Of the ten specimens of *pallidipes* caught or seen on the ox on the two moonlight nights, at least four fed full (at 20.50, 22.25, 22.55 and 1.55) ; a blood-filled male was captured on an African's leg at 5.50, two hours after the ox had been left behind.

The observations also give some information on the relative attractiveness of ox, man and screen. On the moonlight nights 21 specimens were observed on the ox as against 14 on six men (no collections were made from the two front porters). During periods when ox and screen were both present, 10 were seen on the ox and 12 on the screen. During periods when the screen was in use, 23 tsetse occurred on the screen as against 8 on man. The figures are small, and too much stress must not be laid on them, but they suggest that ox and screen are of about equal attractiveness, while man is much less attractive than either. In the daylight round on the 10th July the differences were greater, especially as between man and either of the other baits : 40 specimens were observed on the ox, 29 on the screen and 2 on man. This observation should not be misconstrued as an indication that *G. pallidipes* is not attracted to man : it is well known that man is not a preferred food of this tsetse but he is undoubtedly very attractive to the species in the absence of the preferred sources of blood. One of us (G. H. E. H.) carried out a tsetse survey in the Lambwe valley, in the south-western corner of Kenya, in 1929; the large herds of buck normally to be found there had mostly left owing to the great height of the grass at that season, and the *pallidipes* were so hungry that five or six would be biting each member of the party simultaneously whenever the bush-cover in which the tsetse harboured was approached. So voracious were they that they could easily be caught with one's fingers as they sucked blood.

Table 1.

Showing particulars of *G. pallidipes* caught or seen on a double journey of 2½ miles on moonlight nights; observations before and after midnight are on different nights. Specimens caught are not also recorded as seen. Observations went on continuously but only those occasions on which tsetse were seen are recorded.

| Time | Caught | Seen | Remarks |
|---|---|---|---|
| 19.35 | 1 ♂ | 1 | |
| 19.45 | Nil | 1 | |
| 20.25 | 2 ♀ | 1 | |
| 20.40 | Nil | 2 | |
| 20.50 | Nil | 1 | |
| 21.10 | Nil | 1 | |
| 21.20 | 1 ♀ | Nil | |
| 21.35 | Nil | Nil | End of round. Bush very dense both sides of track. |
| 21.40 | — | — | Return journey begun. |
| 22.25 | Nil | 1 | |
| 22.35 | 1 ♂ | Nil | |
| 22.55 | Nil | 1 | |
| 23.00 | 1 ♂ | Nil | |
| 23.05 | — | — | Camp reached; no light used. |
| 23.30 | 2 ♂, 2 ♀ | 2 | Caught or seen while tethering ox. |
| 0.40 | 1 ♀ | Nil | |
| 0·50 | 1 ♂ | Nil | |
| 0·55 | 1 ♂, 1 ♀ | 1 | |
| 1.15 | 3 ♂ | 1 | |
| 1.30 | 1 ♂, 1 ♀ | Nil | |
| 1.45 | 1 ♂ | 1 | |
| 1.55 | Nil | 1 | |
| 2.05 | — | — | End of outward round. Screen sent on 50 yds. in front of ox. |
| 2.25 | 1 ♀ | Nil | |
| 2.30 | Nil | 1 | |
| 2.40 | 1 ♂, 1 ♀ | Nil | |
| 2.45 | Nil | 1 | |
| 2.55 | 1 ♂ | Nil | A herd of buffalo stampeded and the porters with the screen rejoined the main party. |
| 3.00 | 2 ♀ | Nil | |
| 3.10 | 1 ♀ | 1 | |
| 3.20 | 1 ♂ | Nil | |
| 3.30 | 1 ♂ | Nil | An hour's rest; ox left at camp. |
| 4.45 | 2 ♀ | Nil | |
| 5.05 | Nil | 1 | |
| 5.10 | 1 ♂, 1 ♀ | Nil | |
| 5.15 | 3 ♂ | Nil | |
| 5.17 | 2 ♂ | Nil | |
| 5.25 | 1 ♂ | Nil | |
| 5.35 | Nil | 1 | |
| 5.50 | 2 ♂ | Nil | Birds starting to call. |
| 6.00 | 1 ♀ | Nil | Dawn breaking. Work ceased. |
| TOTALS | 25 ♂, 17 ♀ | 20 | |

### TABLE 2.

Showing specimens of *G. pallidipes* observed on a daylight traverse of the same route. All other conditions as in Table 1.

| Time | Caught | Seen | Remarks |
|---|---|---|---|
| 16.30 | Nil | 3 | |
| 16.45 | 1 ♂ | 5 | |
| 16.47 | 1 ♀ | Nil | |
| 16.50 | Nil | 3 | |
| 17.00 | 1 ♂ | 2 | |
| 17·05 | 3 ♂ | 1 | |
| 17.15 | 1 ♂ | 2 | |
| 17.20 | Nil | 2 | |
| 17.37 | Nil | 1 | Wind dropped. |
| 17.40 | — | — | End of route; return journey begun. |
| 17.50 | Nil | 1 | |
| 17.55 | 1 ♂ | 3 | |
| 18.00 | Nil | 3 | |
| 18.10 | 1 ♀ | 4 | |
| 18.15 | 1 ♂, 1 ♀ | 3 | |
| 18.20 | 3 ♀ | 1 | |
| 18.30 | 2 ♂, 10 ♀ | 1 | |
| 18.35 | 3 ♂, 2 ♀ | " Swarm " following party | |
| 18.40 | 2 ♂, 3 ♀ | 4 | |
| TOTALS | 15 ♂, 21 ♀ | 39 (+ "swarm") | |

## REFERENCE.

VANDERPLANK, F. L., 1941, Activity of *Glossina pallidipes* and the lunar cycle (Diptera). *Proc. R. ent. Soc. Lond.* (A) **16** : 61–64.

## Book Notice.

*A lot of insects. Entomology in a suburban garden.* By Frank E. Lutz. pp. [ix] + 304, illust. 8vo. New York (G. P. Putnam's Sons) (1941). Price $3.

The preface to this book states : " This book is largely a story of American Museum of Natural History expeditions and laboratory experiments. To be sure, these ' expeditions ' took me at most only a few feet from our house and frequently lasted only a few minutes. The ' laboratory ' was sometimes in our cellar, sometimes in one of our flower beds or on the lawn."

The author is the Curator, American Museum of Natural History, and this book is the story of the insects which visited his " estate " of some 75 feet by 200 feet near the centre of an American suburban town. In a talk with his Director, Dr. Lutz expressed the opinion that at least 500 different kinds of insects either lived on or visited his own garden. This caused some incredulity and as the result of some years' observations " he recorded no fewer than 1402 species of 26 different orders." Nor is this the result of making the garden especially attractive to insects at the expense of other interests, for the author is able to record that during the period under discussion he entered his garden for 4 consecutive years in a " garden contest " and won a " certificate of achievement "; 2 bronze medals for second place; and a silver medal for first place. The chapters of the book are entitled : A lot of insects; A visitor from the tropics; Migrating butterflies; Migrating locusts; Blister beetles; Lady beetles; Lions, ant- and aphis; Plant-lice and relatives; An English guest and some of his relatives; A Chinese guest and a walking stick; Insects' commission; Our " domestic " bee; Bumble bees; Ants; " Wasps " and wasps; Termites; Tiger beetles; The tent caterpillar; Butterflies; Moth census; Gipsy and brown-tail moths; Beetles; Aquatic pets; True flies; Adding up; In addition; and Index.

The book is delightfully presented and well illustrated.

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Smith, A., 1936, New species of Coccidae, *Proc. R. ent. Soc. Lond.* (B) **6** : 301–306, pl. 1.

——. 1936, New species of Coccidae, *Trans. R. ent. Soc. Lond.* **84** : 901–936.

Titles of periodicals cited are to be abbreviated in the manner indicated in the *World List of Scientific Periodicals, 2nd edition,* 1934.

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As from January 1936 the journal *Stylops* is continued as *Proceedings Series B. Taxonomy.* Copies of volumes 1–4 are available at *£1 16s. 0d.* each, post free

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TO BE HELD IN THE SOCIETY'S ROOMS

41, Queen's Gate, S.W.7

1942.

WEDNESDAY, October 7
" November 4
" December 2

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